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(54) **High pressure, leak resistant, explosionproof capacitance probe**

Kapazitive, hermetisch dichte, eigensichere Hochdruck-Messsonde

Sonde capacitive étanche et résistant aux explosions et aux hautes pressions

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Description

Background of the Invention

[0001]

1. Field of the Invention

[0002] The invention relates to probes and probe bodies for measuring a desired parameter, such as capacitance. More particularly, the invention relates to a capacitance probe and probe body of the type used for measuring capacitance to detect the level of liquid in a pressure vessel, and still more particularly, to such a probe that resists leakage and, in one embodiment, is explosionproof.

2. Description of the Related Art

[0003] In industrial metrology, capacitance commonly is used to determine the level of liquid in vessels, particularly in closed vessels. One method of measuring capacitance is through the use of a concentric-type plate capacitor. A concentric-type plate capacitor utilizes a conductive probe as the center plate of a coaxial capacitor. This conductive probe is usually a cylindrical metal rod (center or probe rod) that is insulated to measure conductive liquid levels. The vessel walls typically form the second plate of the capacitor while the liquid to be measured is the dielectric. The capacitance of a concentric-type plate capacitor is given by the equation:

$$C = \frac{2 \times \pi \times \epsilon \times L}{\ln\left[\frac{r_0}{r_1}\right]}$$

where

C = capacitance;
ε = dielectric constant (1.000590 for air);
L = length of concentric immersion by the probe rod;
r_0 = radius of the inside of the outer wall of the vessel; and
r_1 = radius of the metallic probe rod.

[0004] The presence of material in the vessel creates a concentric-type plate capacitor with the liquid serving as the dielectric. Therefore, if one knows the dielectric constant of the material in the vessel, by measuring the capacitance, C, it is possible to determine the level of material in the vessel. The probe is connected via suitable electrical connections to capacitance-measuring circuitry. In measuring the capacitance, a lower intrinsic capacitance of the capacitance probe itself is desirable in order to more accurately gauge changes in the overall capacitance that are caused by changes in the liquid level.

[0005] Typical capacitance probes use metallic mounting glands to mount the probe rod to the vessel and to the electronics housing. The internal portion of the mounting gland contains: (1) a pressure sealing system; and (2) a probe rod retaining system. The probe rod itself is typically a metallic rod sheathed in polytetrafluoroethylene (PTFE) or other suitable polymer. The probe rod must pass through the metallic mounting gland with no metallic contact.

[0006] Referring to FIG. 1, an existing capacitance probe includes a packing gland 10 that is threaded into a mounting gland 12. A center rod or probe rod 14 extends from an electronics housing (not shown) through metal packing gland 10 and mounting gland 12 and into a vessel (not shown). Center rod 14 comprises an upper rod 13 that is threaded into a lower rod 15. Because mounting gland 12 is electrically connected to the vessel walls, center rod 14 must be electrically insulated from mounting gland 12 to achieve an accurate capacitance reading. Therefore, a lower sheath 16 surrounds lower rod 15 and an upper sheath 17 surrounds upper rod 13. Sheaths 16 and 17 are typically composed of PTFE although other polymers may be used. A solid PTFE cap or plug 19 insulates the end of lower rod 15 and is joined to lower sheath 16 thermally.

[0007] Housed inside mounting gland 12 is a packing preform 18 that is compressed against lower sheath 16 to form a pressure seal. Packing preform 18 comprises an upper portion 20 and a lower portion 22. Threading on packing gland 10 and mounting gland 12 allows packing gland 10 to be torqued and tightened against packing preform 18 via a PTFE washer 26 and a metallic washer 28. When packing gland 10 is tightened, lower portion 22 of packing preform 18 applies pressure against lower sheath 16 to create a radial pressure seal.

[0008] PTFE and other polymers, however, cold flow under pressure. Thus, lower sheath 16 cold flows in the area that is engaged with lower portion 22 of packing preform 18. This cold flow reduces the pressure seal and allows leakage. Deformation also occurs above and below metallic washer 24 in lower sheath 16 and upper sheath 17.

[0009] These deformations require periodic retorquing of packing gland 10 to maintain compression. As this retorquing process is repeated, lower sheath 16 flows to the point of separation and the seal fails.

[0010] A second difficulty encountered with capacitance probes is the maintenance of center rod 14 against hydrostatic end forces. To solve this problem, existing capacitance probes include one or more metallic washers 24 placed in a groove at a threaded junction point in center rod 14 located within mounting gland 12. Packing preform 18 is made as two separate pieces

rather than one in order to facilitate encapsulation of metallic washer 24. Hydrostatic pressure acts against metallic washer 24 in an upward direction forcing it against upper portion 20 of packing preform 18. Although center rod 14 is contained because the outer diameter of metallic washer 24 is greater than the inner diameter of packing gland 10, cold flow of upper portion 20 may occur. Thus, a capacitance probe capable of reducing or eliminating cold flow of the capacitance probe's PTFE is desirable.

[0011] DE-A-16 48 163 discloses a rod electrode for capacitative fill level measuring for use in a vessel comprising an electrode head having a longitudinal bore extending therethrough, said longitudinal bore having a nominal diameter and an enlarged portion, the enlarged portion defining a stuffing box. A metallic center rod is used as a center plate of a coaxial capacitor and extends through said bore. An insulating sheath made of polytetrafluoroethylene surrounds a lower portion of said center rod, said insulating sheath having a flanged end extending into said stuffing box. Sealing means for sealing the stuffing box between the center rod and the electrode head and for electrically insulating the center rod from the electrode head are provided.

[0012] EP-A-0 101 580 discloses a capacitance probe comprising a mounting gland, a longitudinal bore extending therethrough, a center rod used as a center plate of a coaxial capacitor and extending through said bore, and an insulating material surrounding said center rod. Said center rod also comprises a notch to hold the rod in axial position, and the wall of a vessel is used as the other plate of said coaxial capacitor.

[0013] In addition, a need exists for a capacitance probe and probe body that is explosionproof under the standards promulgated by the National Fire Protection Association in The National Electrical Code® Handbook (5th ed.).

[0014] Finally, a probe and mounting gland apparatus having a lower intrinsic capacitance is desirable because it is difficult to offset large intrinsic capacitances.

Summary of the Invention

[0015] In accordance with the present invention, a capacitance probe and probe body is provided. In accordance with another aspect of the invention, an explosionproof capacitance probe and probe body is provided.

[0016] In accordance with one embodiment of the invention, a capacitance probe is provided that includes a mounting gland having a longitudinal bore extending therethrough. The longitudinal bore has a nominal diameter and an enlarged portion, the enlarged portion defining a stuffing box and a stuffing box bottom. A metallic center rod extends through the bore of the mounting gland and an insulating sheath surrounds a lower portion of the center rod and extends into the stuffing box. Structure is provided for sealing the stuffing box between the center rod and the mounting gland and for electrically insulating the center rod from the mounting gland. Structure is also provided for preventing longitudinal movement of the center rod relative to the mounting gland.

[0017] The structure for sealing the stuffing box can be composed of a plurality of compression deformable chevron packing rings constructed of a suitable material, such as PTFE, contained in the stuffing box coaxial to the bore and surrounding a longitudinal portion of the rod. Structure is provided for compressing the chevron packing rings against the stuffing box bottom, such as by a packing gland threadably secured to the mounting gland and extending into the stuffing box.

[0018] The structure for preventing longitudinal movement can include a circumferential groove in the center rod where the rod is disposed in the stuffing box and a retaining washer disposed in the circumferential groove, with the retaining washer having a larger outer diameter than the nominal diameter of the bore.

[0019] In accordance with another embodiment of the invention, an explosionproof capacitance probe is provided. The explosionproof capacitance probe is composed of a mounting gland having a longitudinal bore extending therethrough, the mounting gland having a cavity coaxial to the bore and a stuffing box at the other end of the mounting gland coaxial to the bore and longitudinally spaced from the cavity by a mounting gland center web. Explosionproof sealing structure is provided for sealing the cavity to provide a flame path seal in the cavity. A metallic center rod extends through the bore with an insulating sheath surrounding a lower portion of the center rod. Structure is provided for sealing the stuffing box between the center rod and the mounting gland and for electrically insulating the center rod from the mounting gland. Structure is also provided for preventing longitudinal movement of the center rod relative to the mounting gland.

[0020] In one embodiment, the structure for sealing the stuffing box is composed of a plurality of compression deformable chevron packing rings located in the stuffing box and coaxial to the bore and surrounding a longitudinal portion of the rod. Structure is provided for compressing the chevron packing rings against the mounting gland center web, such as by a packing gland that can be threadably secured to the mounting gland and to the end of the stuffing box.

[0021] The explosionproof sealing structure comprises a rigid non-electrically conductive polymeric flame path sealing material forming a plug extending from the mounting gland center web towards the cavity end of the mounting gland. Preferably, the plug substantially fills the cavity. The explosionproof sealing structure can further include a jam nut disposed in the flame path seal material that is secured to the metallic center rod and projections on at least one cavity wall of the cavity for mechanically engaging the flame path seal material.

[0022] The structure for preventing longitudinal movement of the explosionproof capacitance probe in one embodiment is the explosionproof sealing structure previously described.

[0023] The foregoing probes and probe bodies reduce or eliminate the cold flow of the insulating sheath surrounding a conductive probe rod. In addition, the cold flow of insulating material (commonly PTFE), is reduced or eliminated in accordance with the present invention. In one embodiment, the end of the PTFE sheath housed in the mounting gland has a 90° flange that is formed by bending a flanged sheath to 90° when secured within the mounting gland to engage the interior of a stuffing box. The stuffing box contains nested chevron packing rings and chevron stack end rings that are squeezed together and deformed to conform to the stuffing box cavity and produce a pressure activated seal between the polymer and the metal. The probe of the present invention withstands higher pressures without the need for periodic retorquing.

[0024] In another embodiment of the present invention, a flame path seal-off is made integral to the gland assembly thereby making the capacitance probe useful in explosionproof applications.

[0025] Each of these two embodiments of the present invention result in a lower intrinsic capacitance than those of existing probes. These lower intrinsic capacitances are easier to offset in the connected circuitry.

Brief Description of the Drawings

[0026]

FIG. 1 is a sectional view of a prior art capacitance probe;

FIG. 2 is a sectional view of one embodiment of the present invention;

FIG. 3 is an exploded sectional view of the embodiment of FIG. 2;

FIG. 4 is a sectional view of a second embodiment of the present invention;

FIG. 5 is an exploded sectional view of the embodiment of FIG. 4;

FIG. 6 is a top perspective view of a chevron packing ring of the type used in the present invention; and

FIG. 7 is a bottom perspective view of a chevron packing ring of the type used in the present invention.

Detailed Description of the Preferred Embodiments

[0027] Referring to FIGS. 2 and 3, a high pressure, leak resistant capacitance probe 11 in accordance with the invention is illustrated. Capacitance probe 11 includes a probe body 21 and a conductive probe rod or center rod 40. Probe body 21 defines a through bore in which probe rod 40 is housed. Probe body 21 includes a mounting gland 30, a packing gland 60 and other components as hereinafter described. Unless otherwise noted, all components of probe 11 are axially symmetrical about the longitudinal centerline of probe 11. Cylindrical mounting gland 30 has outer lower threading 32, outer upper threading 34 and inner upper threading 35. Lower threading 32 is for mounting the capacitance probe in the vessel (not shown). Gland 30 may have a hexagonal longitudinal outer surface to facilitate mounting in a vessel. Upper threading 34 is used to mount the capacitance probe in an electronic housing (not shown). Inner upper threading 35 mates with threading 35' of packing gland 60. A through bore 36 extends through the length of mounting gland 30. Gland 30 defines a cylindrical stuffing box 38 having a common axis with bore 36 and a larger radius than bore 36 extends through the upper portion of mounting gland 30.

[0028] Center rod 40, fabricated of conductive metal, is used as the center plate of the coaxial capacitor. Center rod 40 includes a circumferential groove 41 that extends around the entire circumference of center rod 40 where indicated. Center rod 40 is electrically insulated from mounting gland 30 as hereinafter described. A lower sheath 42 insulates center rod 40 from mounting gland 30. Lower sheath 42 is made of an appropriate insulating polymer, such as PTFE. A solid PTFE cap or plug 43 insulates the end of center rod 40 and is suitably joined to lower sheath 42, such as by thermal joining. Lower sheath 42 has a flanged end 44 perpendicular to the length of lower sheath 42. When placed in mounting gland 30, flanged end 44 of sheath 42 engages bottom 38a of stuffing box 38.

[0029] PTFE flanged end 44 is thermally preformed in a jig from a PTFE tube to form a PTFE tube having about a 75° flange. It is difficult to manufacture flanged end 44 at precisely a 90° angle from the rest of lower sheath 42 from PTFE tubing. Therefore, flanged end 44 is not bent all the way to a 90° angle but rather is formed at an initial angle, e.g., 75° (i.e., forming a 105° angle between lower sheath 42 and flanged end 44). When the capacitance probe is assembled, compression on flanged end 44 is achieved by tightening packing gland 60 in mounting gland 30 to complete the 90° angle bend. When flanged end 44 is bent at 90° from lower sheath 42, the outer diameter of flanged end 44 fits snugly within the inner diameter of stuffing box 38. Alternatively, a prefabricated PTFE tube having a 90° end flange could be used.

[0030] Center rod 40 is placed in lower sheath 42 and then through bore 36 of mounting gland 30. Chevron packing rings 46 made of PTFE are placed around center rod 40 and are used to provide a positive seal because they are deformed under compression due to their geometry. Chevron packing rings 46 are of the type commonly used as valve packing. Chevron stack end rings 48 and 50 provide a planar surface to engage end 44 and a compression washer 52 located above chev-

ron stack end ring 50.

[0031] Referring to FIGS. 6 and 7, a chevron packing ring 46 of the type used in the present invention is illustrated. Chevron packing ring 46 includes a top side 118 and a bottom side 120. Top side 118 is tapered in an upward direction. Bottom side 120 is also tapered in an upward direction. The shape of top side 118 and bottom side 120 are reciprocating, i.e., chevron packing glands 46 are stacked by placing the bottom side 120 of one chevron packing ring 46 directly on top of the top side 118 of a second chevron packing ring 46. Upon compression, both top side 118 and bottom side 120 tend to flatten. As a result, inside 122 of chevron packing ring 46 is urged towards center rod 40 in stuffing box 38. Similarly, outside 124 of chevron packing ring 46 is urged outward against mounting gland 30.

[0032] Compression washer 52 is made from a dense, nonconductive material, e.g., compressed fiber or G.E. Ultem 1000. Compression washer 52 is located relative to center rod 40 just below groove 41. A metallic retaining washer 54 is a split ring that surrounds center rod 40 in groove 41. Retaining washer 54 is larger in outer diameter than the inner diameter of packing gland 60 and the diameter of bore 36 to maintain center rod 40 retention in case of gland following washer 58 failure. Next, an outside washer 56, which may be made of the same material as compression washer 52, is placed about retaining washer 54. A gland following washer 58, which may be made from the same material as compression washer 52 and outside washer 56, is placed around center rod 40. Gland following washer 58 provides a bearing surface for a packing gland 60. Upper sheath 62 (also made of PTFE) is then placed around center rod 40 to provide electrical isolation from packing gland 60 when packing gland 60 is threadably tightened within mounting gland 30.

[0033] Finally, packing gland 60 is placed over center rod 40 and upper sheath 62. Packing gland 60 is then threaded into the upper portion of stuffing box 38. As packing gland 60 is tightened, it pushes downward on gland following washer 58. Gland following washer 58 in turn pushes down on retaining washer 54 and outside washer 56. Because retaining washer 54 is located in groove 41, retaining washer 54 urges center rod 40 downward. Retaining washer 54 and outside washer 56 also urge compression washer 52 downward into upper end chevron packing ring 50. Chevron packing rings 46 are spread thereby creating an effective seal. End 44 of lower sheath 42 is maintained against the lower portion of stuffing box 38. In this manner, the capacitance probe is sealed between the center rod 40 and mounting gland 30 and electrically insulated from mounting gland 30.

[0034] Cold flow of the PTFE of the probe is reduced or eliminated because there is no cavity into which the PTFE can flow. Moreover, the only PTFE portion that is compressed is flanged end 44 of lower sheath 42. The hydrostatic end forces, however, tend to relieve this compression to reduce any possibility of cold flow of the PTFE. In prior art capacitance probes, the hydrostatic end forces contributed to compression of the PTFE in some areas thereby increasing the likelihood of cold flow.

[0035] In addition to providing an effective seal, capacitance probe 11 effectively retains center rod 40 without permitting longitudinal movement of rod 40 with respect to probe body 21. Center rod 40 is retained in position because retaining washer 54 engages groove 41 of center rod 40. Therefore, center rod 40 moves vertically only to the extent that retaining washer 54 moves vertically. Because retaining washer 54 engages gland following washer 58 and gland following washer 58 is maintained in place by threaded packing gland 60, center rod 40 cannot move relatively vertically upward with respect to probe body 21. The engagement of end 44 against the lower portion of stuffing box 38, in combination with the elimination of the cold flow of the PTFE, prevents any relative downward vertical movement of center rod 40 with respect to probe body 21.

[0036] Because of the shorter coaxial length of center rod 40 and glands 30 and 60, the larger diameter of the dielectric portion (i.e., that portion between center rod 40 and mounting gland 30) of probe 11 and the larger separation between retaining washer 54 and packing gland 60, (as compared to the separation between metallic washer 24 and packing gland 10 of FIG. 1) as compared to existing capacitance probes, intrinsic probe capacitance is reduced significantly over that of existing capacitance probes. Because the present invention has a lower intrinsic probe capacitance, more accurate and reliable liquid level measurements are obtained.

[0037] Another embodiment of the present invention can be used in explosionproof applications. Referring to FIG. 4, an explosionproof capacitance probe 66 in accordance with the invention is illustrated. Probe 66 includes a probe body 67 and a center rod or probe rod 68. Probe body 67 includes a cylindrical mounting gland 70 having lower threading 72 and upper threading 74. Lower threading 72 is for mounting the capacitance probe in the vessel (not shown). Upper threading 74 is used to mount the capacitance probe in an electronic housing (not shown). A through bore 76 extends through the length of mounting gland 70. A cylindrical stuffing box 78 defines an enlarged bore portion 76' and thus has a common axis with bore 76 and a larger radius than bore 76 defined by and extending through the lower part of mounting gland 70. The lower portion of stuffing box 78 defined by mounting gland 70 is threaded to receive a packing gland 80.

[0038] A cylindrical threaded cavity 82 having projections from the wall thereof, in this embodiment truncated threading 83, is provided. Cavity 82 defines an enlarged bore portion 76" and thus has a common axis with bore 76 and a larger radius than bore 76 defined by and extending through the upper part of mounting gland 70. A retained center web 84 separates threaded cavity

82 and stuffing box 78. Center rod 68 of the present embodiment comprises a sensing rod 86 and a threaded rod 88 that is threaded into sensing rod 86. The portion of threaded rod 88 that sits within retained center web 84 is not threaded.

[0039] Although in this embodiment the center rod is made of two pieces, the center rod could be a single piece. The advantage of having two separate pieces is that sensing rod 86 has a larger radius than threaded rod 88. Because the radius of the vessel is substantially larger than the radius of the center rod, a larger center rod radius yields more accurate capacitance measurements. If the entire center rod were to have this larger radius, the probe would have an increased intrinsic capacitance. Thus, threaded rod 88 has a relatively smaller radius while sensing rod 86 has a larger radius.

[0040] A high density, nonconductive top washer 90 which can be constructed from, e.g., compressed fiber or G.E. Ultem 1000, and having a clearance hole for threaded rod 88, is placed within stuffing box 78 against retained center web 84. A metallic inside washer 92 is placed next to top washer 90. An outside washer 94 which can be made of the same material as top washer 90 encircles inside washer 92. Bottom washer 96 which can be made of the same material as top washer 90 and outside washer 94 is placed next to inside washer 92 and outside washer 94. Bottom washer 96 has a clearance hole to accommodate sensing rod 86. Metallic inside washer 92 is retained by a dense non-conductive material with high shear resistance providing excellent static load deformation resistance to developed hydrostatic end forces. This resistance is enhanced by the rigidity of the integral flame path seal-off assembly as described below. Chevron packing rings 98 are placed around sensing rod 86 as are chevron stack end rings 100 and 102. Chevron stack end rings 100 and 102 provide a planar surface to engage bottom washer 96 and an end 104 of a sheath 106, respectively.

[0041] Sheath 106 insulates sensing rod 86. Sheath 106 can be made of PTFE or a similar polymer. A solid PTFE cap 107 insulates the end of sensing rod 86 and is joined to sheath 106 thermally. End 104 of sheath 106 is bent to an angle in the same manner that end 44 of sheath 42 of the previous embodiment is created. A metallic gland following washer 108 engages end 104. Finally, packing gland 80 is threaded into the lower portion of stuffing box 78.

[0042] Threaded rod 88 is screwed into sensing rod 86. A sheath ring 112, which may be made of PTFE, is then placed around threaded rod 88. At approximately the center of threaded cavity 82, a pair of jam nuts 114 are jam threaded onto threaded rod 88. Threaded cavity 82 is then filled with an acceptable flame path seal-off material 116 which generally will be a rigid non-electrically conductive polymeric material. Flame path seal-off material 116 may be Epoxy No. 2850 FT-FR mixed with Catalyst No. 11 both available from Emerson & Cuming, Dewey & Almy Chemical Division, W.R. Grace & Co., Canton, Massachusetts, or another suitable cement or epoxy. Truncated threading 83 in threaded cavity 82 provides mechanical connection of flame path seal-off material 116 with gland 70. Jam nuts 114 disposed in material 116 prevent longitudinal movement of rod 88 relative to gland 70. Material 116 is preferably placed in cavity 82 in fluid form and thereafter suitably cured or solidified. This assures intimate and secure contact and attachment between material 116, cavity 82, rod 88 and jam nuts 114.

[0043] Sheath end 104 is held in flat compression by metallic gland following washer 108. Thus, the PTFE has no cavities available in which to cold flow. Moreover, hydrostatic end forces tend to relieve any PTFE compression at this point. Chevron packing rings 98 provide a tight seal that does not require periodic retorquing to compensate for cold flow. Because packing gland 80 does not require retorquing, packing gland 80 may be located in areas not possible with existing probes. For example, packing gland 80 can be placed in the inside of the vessel.

[0044] A conductive wire 117 is suitably attached to mounting gland 70 and serves as a ground reference. A second conductive wire 119 is electrically connected to probe rod 68 and to an electronic circuit board (not shown). A washer 121 and a screw 123 facilitate the connection of wire 119 to probe rod 68.

[0045] Sensing rod 86 and threaded rod 88 are prevented from being ejected in the case of an explosion by flame path seal-off material 116 being engaged with truncated threading 83 of threaded cavity 82 and jam nuts 114. As a final safety, the inner diameter of retained center web 84 is considerably smaller than the diameter of jam nuts 114 and inside washer 92.

[0046] Whereas the present invention has been described with respect to specific embodiments thereof, it will be understood that various changes and modifications will be suggested to one skilled in the art and it is intended that the invention encompass such changes and modifications as fall within the scope of the appended claims.

Claims

1. A capacitance probe (11; 66) for use in a vessel, wherein the wall of the vessel is used as one plate of a coaxial capacitor, comprising:

   a mounting gland (30; 70) having a longitudinal bore (36; 76) extending therethrough, said longitudinal bore having a nominal diameter and an enlarged portion (76'), the enlarged portion defining a stuffing box (38; 78);
   a metallic center rod (40; 68) used as a center plate of the coaxial capacitor, said center rod extending through the bore (36; 76) of said mounting gland (30; 70);
   an insulating sheath (42; 106) surrounding a

lower portion of said center rod (40; 68), said insulating sheath having a flanged end (44; 104) extending into said stuffing box (38; 78), said insulating sheath (42; 106) and flanged end (44; 104) being made of an insulating polymer which cold flows under pressure such as polytetrafluoroethylene (PTFE);

sealing means (46 , 48, 50, 52, 60; 80, 96, 98, 100, 102, 108) for sealing the stuffing box between the center rod and the mounting gland and for electrically insulating the center rod from the mounting gland; and

means (41, 54, 56, 58; 83, 114, 116) for preventing longitudinal movement of said center rod relative to said mounting gland;

characterized in that

said flanged end (44; 104) forms an angle of about 90° with the remainder of the insulating sheath (42; 106).

2. The capacitance probe of claim 1, wherein

said enlarged portion of said longitudinal bore (36) defines a stuffing box bottom (38a);

said sealing means (46, 48, 50, 52, 60) for sealing the stuffing box (38) comprises a plurality of compression deformable chevron packing rings (46) contained in said stuffing box (38) coaxial to said bore (36) and surrounding a longitudinal portion of said rod (40); and

means (48, 50, 52, 60) for compressing said chevron packing rings (46) against said flanged end of said insulating sheath.

3. The probe of claim 2, wherein said compressing means (48, 50, 52, 60) comprises a packing gland (60) secured to the mounting gland and extending into said stuffing box.

4. The probe of claim 3, wherein said stuffing box (38) is threaded to receive said packing gland (60).

5. The probe of claim 1, 2, 3 or 4, wherein said means (41, 54, 56, 58) for preventing longitudinal movement comprises:

a circumferential groove (41) in said center rod (40) where said rod is disposed in said stuffing box (38);

a retaining washer (54) disposed in said circumferential groove (41), said retaining washer having a larger outer diameter than the nominal diameter of said bore (36).

6. The probe of claim 5, wherein said means (41, 54, 56, 58) for preventing longitudinal movement further comprises:

a gland following washer (58) to engage said retaining washer.

7. The probe of claim 6, wherein said means (41, 54, 56, 58) for preventing longitudinal movement further comprises an outside washer (56) surrounding said retaining washer (54) ; and

said compressing means (48, 50, 52, 60) further comprises a compression washer (52) disposed between said retaining washer (54) and said plurality of packing rings (46).

8. The probe of any preceding claim, wherein said sealing means (46, 48, 50, 52, 60) for sealing the stuffing box (38) is pressure activated.

9. A capacitance probe (66) according to claim 1, said probe being a explosionproof capacitance probe (66) characterized by:

said mounting gland (70) at one end having a cavity (82) coaxial to said bore (76) and said stuffing box (78) at the other end of said mounting gland (70) coaxial to said bore (76) and longitudinally spaced from said cavity (82) by a mounting gland center web (84); and

characterized by further comprising

explosionproof sealing means (83, 114, 116) for sealing the cavity to provide a flame path seal in said cavity (82).

10. The probe of claim 9, wherein said means (80, 96, 98, 100, 102, 108) for sealing the stuffing box (78) comprises a plurality of compression deformable chevron packing rings (98) contained in said stuffing box coaxial to said bore (76) and surrounding a longitudinal portion of said center rod (68); and

means (80, 100, 102, 108) for compressing said chevron packing rings (98) against said mounting gland center web (84).

11. The probe of claim 10, wherein said compressing means (80, 100, 102, 108) comprises a packing gland (80) secured to the mounting gland (70) and extending into said stuffing box (78).

12. The probe of claim 11, wherein said stuffing box (78) is threaded to receive said packing gland (80).

13. The probe of claim 9, 10, 11 or 12, wherein said explosionproof sealing means (83, 114, 116) comprises a rigid non-electrically conductive polymeric flame path seal-off material forming a plug extending from the mounting gland center web (84) towards the cavity end of the mounting gland (70).

14. The probe of claim 13, wherein the plug substantially fills the cavity (82).

15. The probe of claim 13, wherein said explosionproof sealing means (83, 114, 116) further comprises:

a jam nut (114) disposed in the flame path seal-off material and secured to the metallic center rod (68); and
wherein said cavity (82) has at least one cavity wall having projections (83) thereon to mechanically engage said flame path seal-off material.

16. The probe of claim 13, wherein said flame path seal-off material is epoxy resin.

Patentansprüche

1. Eine Kapazitätssonde (11; 66) zur Verwendung in einem Gefäß, wobei die Wand des Gefäßes als eine Platte eines konzentrischen Kondensators verwendet wird, mit:

einem Montageflansch (30; 70) mit einer sich hindurch erstreckenden Längsbohrung (36; 75), wobei die Längsbohrung einen Nenndurchmesser und einen vergrößerten Bereich (76') besitzt, wobei der vergrößerte Bereich eine Stopfbuchse (38; 78) definiert;

einem zentralen Stab (40; 58) aus Metall, der als eine zentrale Platte des konzentrischen Kondensators verwendet wird, wobei der zentrale Stab sich durch die Bohrung (36; 76) des Montageflansches (30; 70) hindurch erstreckt;

einer Isolierhülle (42; 106), die einen unteren Bereich des zentralen Stabes (40; 68) umgibt, wobei die Isolierhülle ein angeflanschtes Ende (44; 104) besitzt, das sich in die Stopfbuchse (38; 78) hinein erstreckt, wobei die Isolierhülle (42; 106) und das angeflanschte Ende (44; 104) aus einem isolierenden Polymer bestehen, das unter Druck kaltfließt, wie z.B. Polytetrafluorethylen (PTFE);

einer Dichtungseinrichtung (46, 48, 50, 52, 60; 80, 96, 98, 100, 102, 108) zum Abdichten der Stopfbuchse zwischen dem zentralen Stab und dem Montageflansch und zum elektrisch Isolieren des zentralen Stabes von dem Montageflansch; und

einer Einrichtung (41, 54, 56, 58; 83, 114, 116) zum Verhindern einer Bewegung des zentralen Stabes relativ zu dem Montageflansch in Längsrichtung;

dadurch gekennzeichnet, daß

das angeflanschte Ende (44; 104) mit dem Rest der Isolierhülle (42; 106) einen Winkel von ungefähr 90° bildet.

2. Die Kapazitätssonde nach Anspruch 1, dadurch gekennzeichnet, daß

der vergrößerte Bereich der Längsbohrung (36) einen Stopfbuchsenboden (38a) definiert;

die Dichtungseinrichtung (46, 48, 50, 52, 60) zum Abdichten der Stopfbuchse (38) eine Vielzahl von durch Druck deformierbare Chevron-Dichtungsringen (46), die in der Stopfbuchse (38) konzentrisch zu der Bohrung (36) enthalten sind und einen Längsbereich des Stabes (40) umgeben, und

eine Einrichtung (48, 50, 52, 60) zum Komprimieren der Chevron-Dichtungsringe (46) gegen das angeflanschte Ende der Isolierhülle aufweist.

3. Die Sonde nach Anspruch 2, dadurch gekennzeichnet, daß die Komprimiereinrichtung (48, 50, 52, 60) einen Dichtungsflansch (60) aufweist, der an dem Montageflansch befestigt ist und sich in die Stopfbuchse hinein erstreckt.

4. Die Sonde nach Anspruch 3, dadurch gekennzeichnet, daß die Stopfbuchse (38) ein Gewinde besitzt, um den Dichtungsflansch (60) aufzunehmen.

5. Die Sonde nach Anspruch 1, 2, 3 oder 4, dadurch gekennzeichnet, daß die Einrichtung (41, 54, 56, 58) zum Verhindern einer Bewegung in Längsrichtung aufweist:

eine periphere Nut (41) in dem zentralen Stab (40) dort, wo der Stab in der Stopfbuchse (38) angeordnet wird;

eine Haltescheibe (54), die in der peripheren Nut (41) angeordnet wird, wobei die Haltescheibe einen Außendurchmesser besitzt, der größer ist als der Nenndurchmesser der Bohrung (36).

6. Die Sonde nach Anspruch 5, dadurch gekennzeichnet, daß die Einrichtung (41, 54, 56, 58) zum Verhindern einer Bewegung in Längsrichtung des weiteren aufweist:

eine Flanschfolgescheibe (58), um mit der Haltescheibe in Eingriff zu stehen.

7. Die Sonde nach Anspruch 6, dadurch gekennzeichnet, daß die Einrichtung (41, 54, 56, 58) zum Verhindern einer Bewegung in Längsrichtung des weiteren eine Außenscheibe (56) aufweist, die die Haltescheibe (54) umgibt; und

   die Komprimiereinrichtung (48, 50. 52, 60) des weiteren eine Druckscheibe (52) aufweist, die zwischen der Haltescheibe (54) und der Vielzahl von Dichtungsringen (46) angeordnet wird.

8. Die Sonde nach irgendeinem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Dichtungseinrichtung (46, 48, 50, 52, 60) zum Abdichten der Stopfbuchse (38) durch Druck aktiviert wird.

9. Eine Kapazitätssonde (66) gemäß Anspruch 1, wobei die Sonde eine explosionssichere Kapazitätssonde (66) ist, dadurch gekennzeichnet, daß:

   der Montageflansch (70) an einem Ende eine Aussparung (82) besitzt, die konzentrisch zu der Bohrung (76) und der Stopfbuchse (78) an dem anderen Ende des Montageflansches (70) ist, die konzentrisch zu der Bohrung (76) und von der Aussparung (82) durch einen zentralen Steg (84) des Montageflansches in Längsrichtung beabstandet ist; und
   dadurch gekennzeichnet, daß die Sonde des weiteren eine explosionssichere Dichtungseinrichtung (83, 114, 116) zum Abdichten der Aussparung aufweist, um in der Aussparung (82) ein Flammwegsiegel bereitzustellen.

10. Die Sonde nach Anspruch 9, dadurch gekennzeichnet, daß die Einrichtung (80, 96, 98, 100, 102, 108) zum Abdichten der Stopfbuchse (78) eine Vielzahl von durch Druck deformierbare Chevron-Dichtungsringen (98), die in der Stopfbuchse konzentrisch zu der Bohrung (76) enthalten sind und einen Längsbereich des zentralen Stabes (68) umgeben, und

    eine Einrichtung (80, 100, 102, 106) zum Komprimieren der Chevron-Dichtungsringe (98) gegen den zentralen Steg (84) des Montageflansches aufweist.

11. Die Sonde nach Anspruch 10, dadurch gekennzeichnet, daß die Komprimiereinrichtung (80, 100, 102, 108) einen Dichtungsflansch (80) aufweist, der an dem Montageflansch (70) befestigt ist und sich in die Stopfbuchse (78) hinein erstreckt.

12. Die Sonde nach Anspruch 11, dadurch gekennzeichnet, daß die Stopfbuchse (78) ein Gewinde besitzt, um den Dichtungsflansch (80) aufzunehmen.

13. Die Sonde nach Anspruch 9, 10, 11 oder 12, dadurch gekennzeichnet, daß die explosionssichere Dichtungseinrichtung (83, 114, 116) ein steifes, elektrisch nicht-leitendes, polymeres Flammwegversiegelungsmaterial aufweist, das einen Stopfen bildet, der sich von dem zentralen Steg (84) des Montageflansches in Richtung des Endes der Aussparung des Montageflansches (70) erstreckt.

14. Die Sonde nach Anspruch 13, dadurch gekennzeichnet, daß der Stopfen im wesentlichen die Aussparung (82) füllt.

15. Die Sonde nach Anspruch 13, dadurch gekennzeichnet, daß die explosionssichere Dichtungseinrichtung (83, 114, 116) des weiteren aufweist:

    eine Gegenmutter (114), die in dem Flammwegversiegelungsmaterial angeordnet und an dem zentralen Stab (68) aus Metall befestigt ist; und
    wobei die Aussparung (82) wenigstens eine Wand mit Vorsprüngen (83) darauf besitzt, um mit dem Flammwegversiegelungsmaterial mechanisch in Eingriff zu stehen.

16. Die Sonde nach Anspruch 13, dadurch gekennzeichnet, daß das Flammwegversiegelungsmaterial Epoxidharz ist.

Revendications

1. Sonde capacitive (11; 66) destinée à être utilisée dans une cuve, la paroi de la cuve étant utilisée comme une plaque d'un condensateur coaxial, comportant :

   un presse-étoupe de montage (30; 70) ayant un alésage longitudinal (36; 76) s'étendant à travers celui-ci, ledit alésage longitudinal ayant un diamètre nominal et une partie agrandie (76'), la partie agrandie définissant une boîte à garniture (38; 78);
   une tige centrale métallique (40; 68) utilisée comme plaque centrale du condensateur coaxial, ladite tige centrale passant à travers l'alésage (36; 76) dudit presse-étoupe de montage (30; 70);
   une gaine isolante (42; 106) entourant une partie inférieure de ladite tige centrale (40; 68), ladite gaine isolante ayant une extrémité à rebord (44; 104) s'étendant dans ladite boîte à garniture (38; 78), ladite gaine isolante (42; 106) et ladite extrémité à rebord (44; 104) étant constituées d'un polymère isolant qui s'écoule

à froid sous pression tel que le polytétrafluoroéthylène (PTFE);

des moyens d'étanchéité (46, 48, 50, 52, 60; 80, 96, 98, 100, 102, 108) destinés à assurer l'étanchéité de la boîte à garniture entre la fige centrale et le presse-étoupe de montage et à isoler électriquement la tige centrale du presse-étoupe de montage; et

des moyens (41, 54, 56, 58; 83, 114, 116) destinés à empêcher le mouvement longitudinal de ladite tige centrale par rapport audit presse-étoupe de montage;

caractérisée en ce que

ladite extrémité à rebord (44; 104) forme un angle d'environ 90° avec le reste de la gaine isolante (42; 106).

2. Sonde capacitive selon la revendication 1, dans laquelle

ladite partie agrandie dudit alésage longitudinal (36) définit un fond de boîte à garniture (38a);

lesdits moyens d'étanchéité (46, 48, 50, 52, 60) destinés à assurer l'étanchéité de la boîte à garniture (38) comportent une pluralité de bagues d'étoupage en chevron déformables par compression (46) contenues dans ladite boîte à garniture (38) coaxiales audit alésage (36) et entourant une partie longitudinale de ladite tige (40); et

des moyens (48, 50, 52, 60) destinés à comprimer lesdites bagues d'étoupage en chevron (46) contre ladite extrémité à rebord de ladite gaine isolante.

3. Sonde selon la revendication 2, dans laquelle lesdits moyens de compression (48, 50, 52, 60) comportent un presse-garniture (60) fixé sur le presse-étoupe de montage et s'étendant dans ladite boîte à garniture.

4. Sonde selon la revendication 3, dans laquelle ladite boîte à garniture (38) est filetée afin de recevoir ledit presse-garniture (60).

5. Sonde selon la revendication 1, 2, 3 ou 4, dans laquelle lesdits moyens (41, 54, 56, 58) destinés à empêcher le mouvement longitudinal comportent :

une rainure circonférentielle (41) dans ladite tige centrale (40) où ladite tige est disposée dans ladite boîte à garniture (38);

une rondelle d'arrêt (54) disposée dans ladite rainure circonférentielle (41), ladite rondelle de retenue ayant un diamètre extérieur plus grand que le diamètre nominal dudit alésage (36).

6. Sonde selon la revendication 5, dans laquelle lesdits moyens (41, 54, 56, 58) destinés à empêcher le mouvement longitudinal comportent en outre :

une rondelle suiveuse de presse-garniture (58) destinée à mettre en prise ladite rondelle d'arrêt.

7. Sonde selon la revendication 6, dans laquelle lesdits moyens (41, 54, 56, 58) destinés à empêcher le mouvement longitudinal comportent en outre une rondelle extérieure (56) entourant ladite rondelle d'arrêt (54); et

lesdits moyens de compression (48, 50, 52, 60) comportent en outre une rondelle de compression (52) disposée entre ladite rondelle d'arrêt (54) et ladite pluralité de bagues d'étoupage (46).

8. Sonde selon l'une quelconque des revendications précédentes, dans laquelle lesdits moyens d'étanchéité (46, 48, 50, 52, 60) destinés à assurer l'étanchéité de la boîte à garniture (38) sont activés par pression.

9. Sonde capacitive (66) selon la revendication 1, ladite sonde étant une sonde capacitive anti-déflagrante (66) caractérisée par :

ledit presse-étoupe de montage (70) à une extrémité ayant une cavité (82) coaxiale audit alésage (76) et ladite boîte à garniture (78) à l'autre extrémité dudit presse-étoupe de montage (70) étant coaxiale audit alésage (76) et longitudinalement espacée de ladite cavité (82) par une âme centrale de presse-étoupe de montage (84); et

caractérisée en ce qu'elle comporte en outre

des moyens d'étanchéité anti-déflagrants (83, 114, 116) destinés à assurer l'étanchéité de la cavité procurant un joint de passage de flamme dans ladite cavité (82).

10. Sonde selon la revendication 9, dans laquelle lesdits moyens (80, 96, 98, 100, 102, 108) destinés à assurer l'étanchéité de la boîte à garniture (78) comportent une pluralité de bagues d'étoupage en chevron déformables par compression (98) contenues dans ladite boîte à garniture coaxiales audit alésage (76) et entourant une partie longitudinale de ladite tige centrale (68); et

des moyens (80, 100, 102, 108) destinés à comprimer lesdites bagues d'étoupage en chevron (98) contre ladite âme centrale de presse-étoupe de montage (84).

11. Sonde selon la revendication 10, dans laquelle lesdits moyens de compression (80, 100, 102, 108) comportent un presse-garniture (80) fixé sur le presse-étoupe de montage (70) et s'étendant dans ladite boîte à garniture (78).

12. Sonde selon la revendication 11, dans laquelle ladite boîte à garniture (78) est filetée pour recevoir ledit presse-garniture (80).

13. Sonde selon la revendication 9, 10, 11 ou 12, dans laquelle lesdits moyens d'étanchéité anti-déflagrants (83, 114, 116) comportent une matière rigide d'obturation de passage de flamme en polymère électriquement non-conducteur formant un bouchon s'étendant de l'âme centrale de presse-étoupe de montage (84) à l'extrémité de cavité du presse-étoupe de montage (70).

14. Sonde selon la revendication 13, dans laquelle le bouchon remplit de manière substantielle la cavité (82).

15. Sonde selon la revendication 13, dans laquelle lesdits moyens d'étanchéité anti-déflagrants (83, 114, 116) comportent en outre :

    un contre-écrou (114) disposé dans la matière d'obturation de passage de flamme et fixé sur la tige centrale métallique (68); et
    ladite cavité (82) ayant au moins une paroi de cavité comportant des saillies (83) destinées à mettre en prise mécaniquement ladite matière d'obturation de passage de flamme.

16. Sonde selon la revendication 13, dans laquelle ladite matière d'obturation de passage de flamme est une résine époxy.

Fig. 1

Prior Art

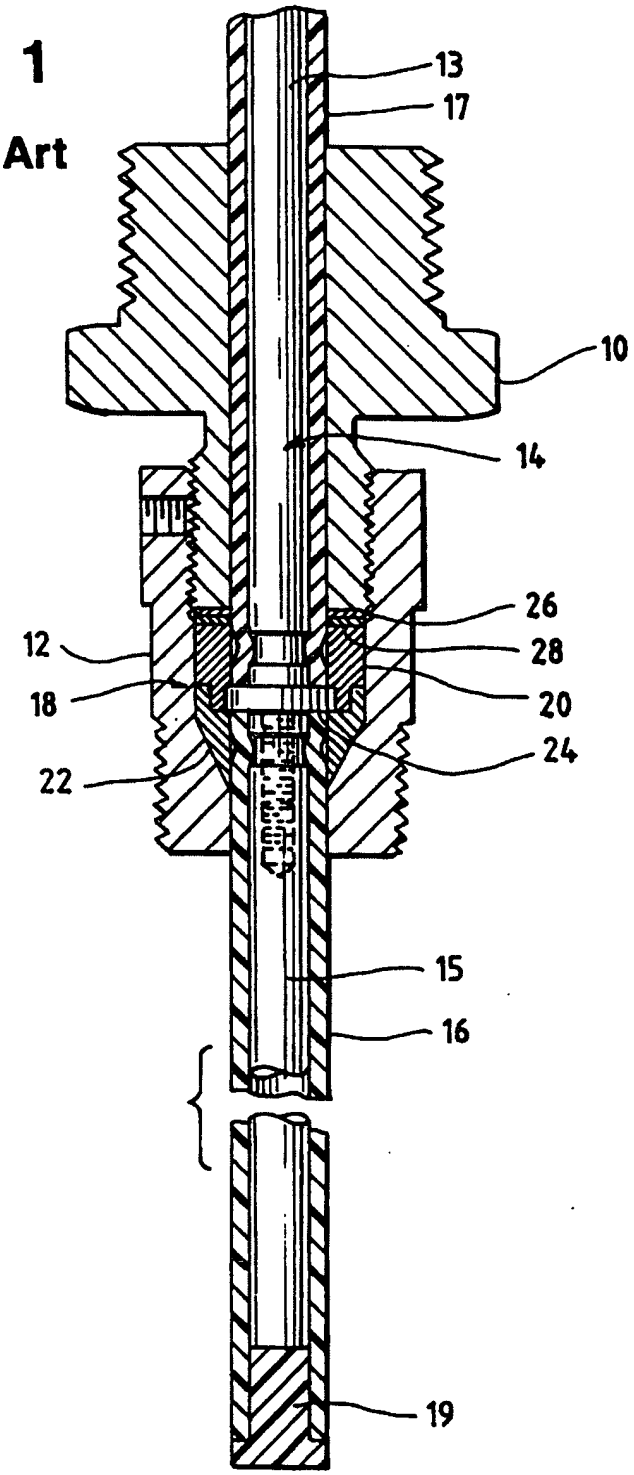
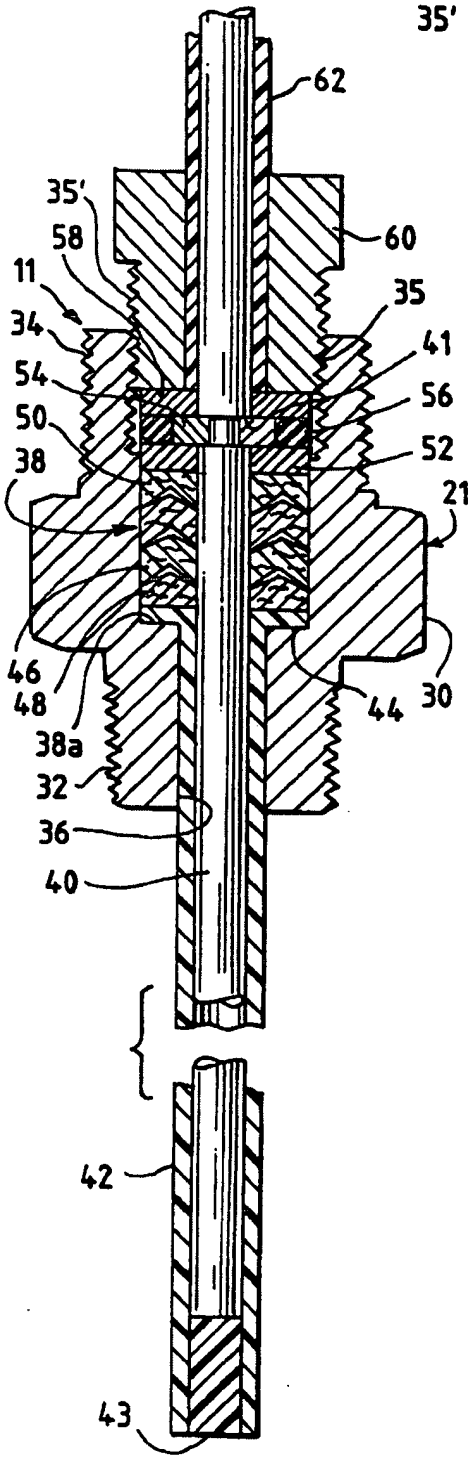


Fig. 2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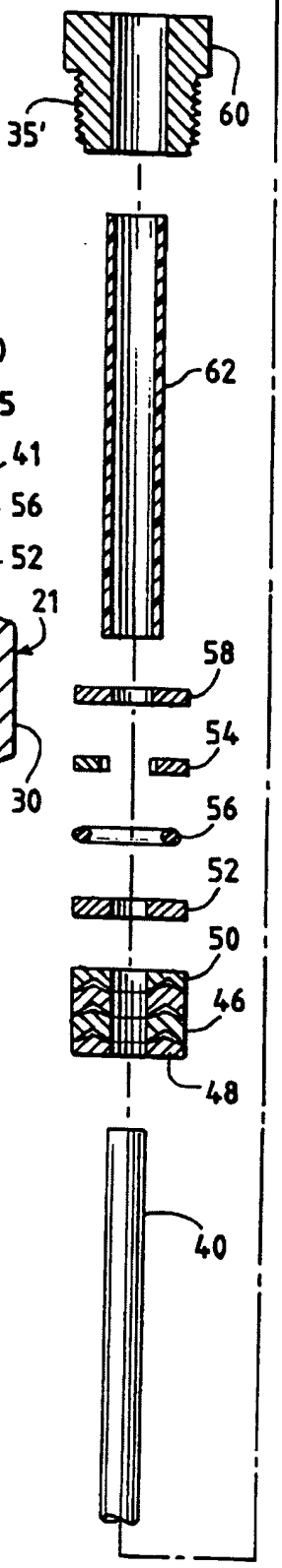
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Fig. 3

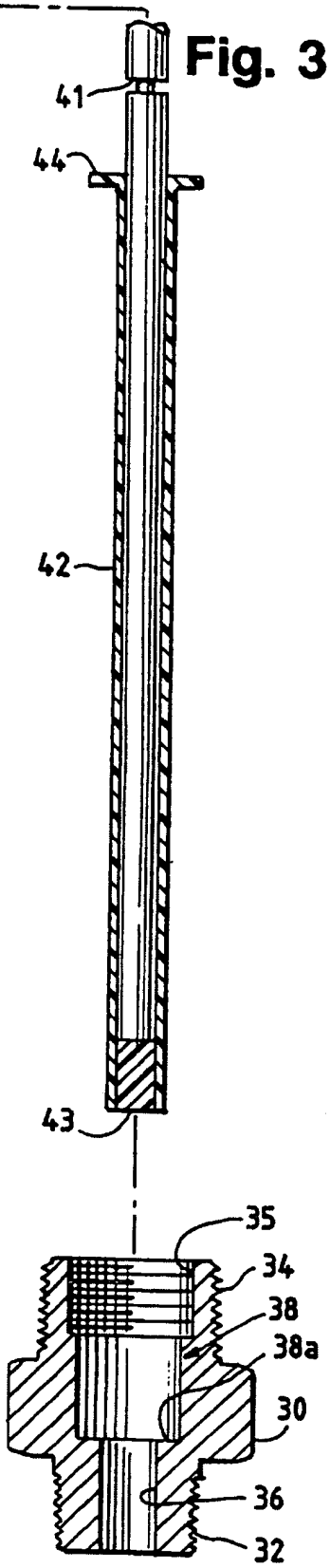
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Fig. 4

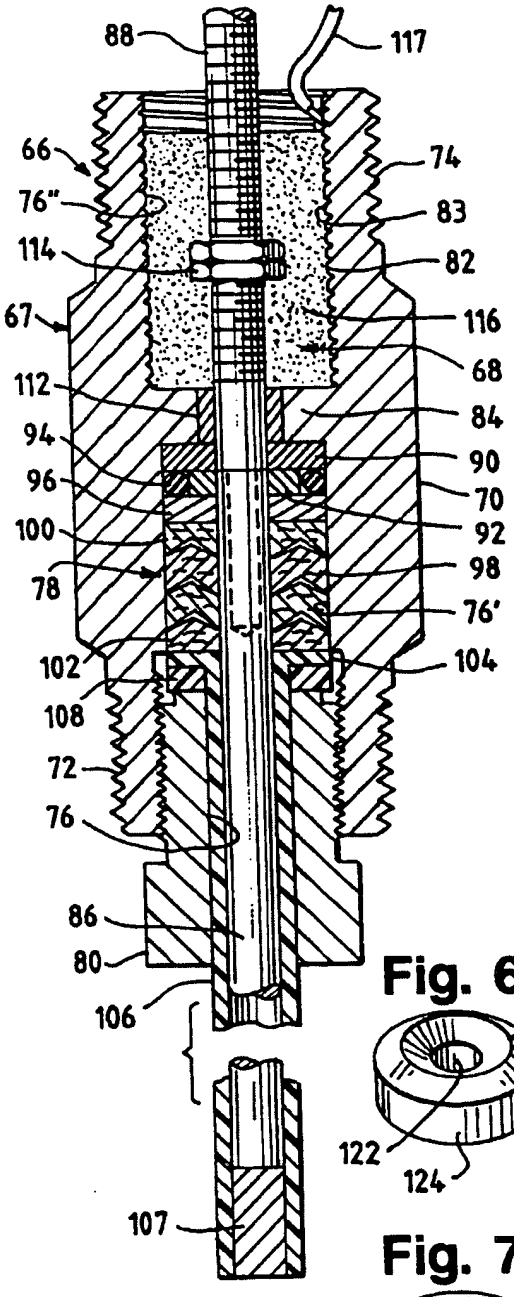

Fig. 5

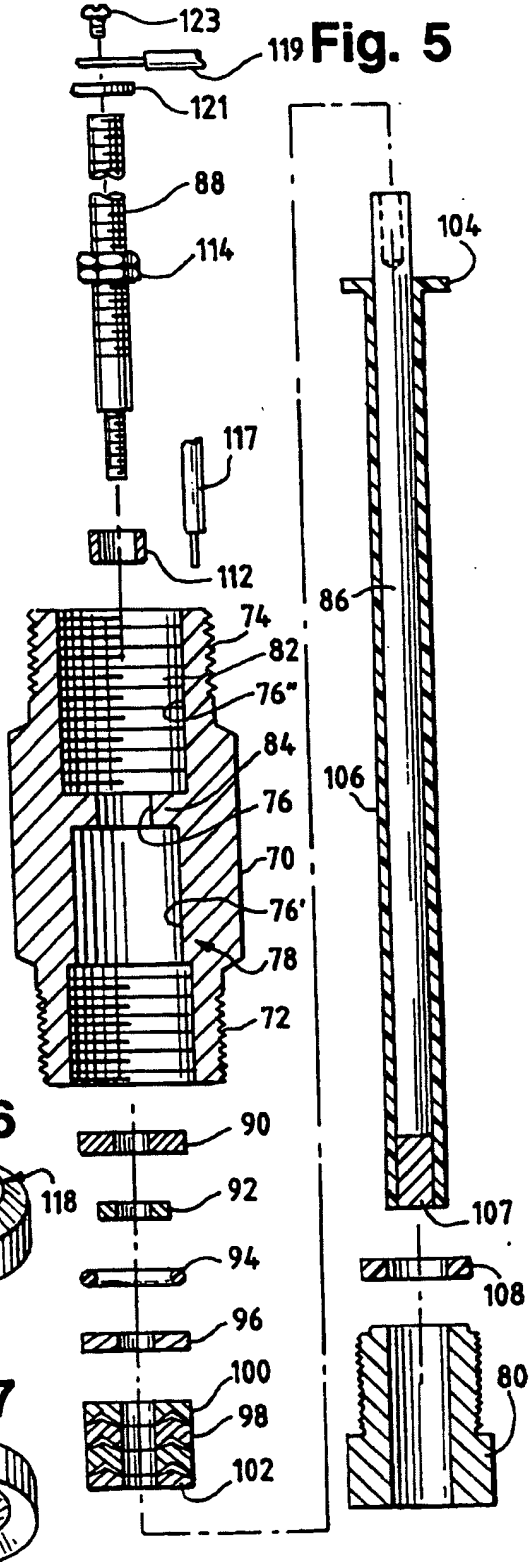

Fig. 6

Fig. 7